EVALUATION OF LOW ALTITUDE ROCKET DROPSONDES FOR SHIPBOARD ATMOSPHERIC PROFILING AND ELECTROMAGNETIC PROPAGATION ASSESSMENT

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A study was performed on two measurement systems used to obtain profiles of refraction from a ship–the radiosonde and the rocketsonde. Refractive conditions measured by the Marwin Rawinsonde Set (MRS) utilizing radiosondes launched from U.S. Navy ships can yield misleading modified refractivity (M) versus height profiles. MRS obtained M unit profiles, when incorporated in propagation loss models such as Radio Physical Optics (RPO), also may produce unrepresentative propagation loss assessments. Rocketsonde obtained environmental parameters (temperature, relative humidity, pressure) are measured away from the ships influence. The ship can modify the environmental parameters and affect temperatures by as much as 3°C. Rocketsonde obtained data yield improved fine-scale vertical resolution. Resolution approaching 5m obtained via rocketsondes is found to most closely resemble the actual environment. Rocketsonde data is available down to the near-surface whereas there is a distinct lack of data from the surface to the launch point when utilizing balloon launched radiosondes. Inaccuracies in initial surface data drastically impact refractive profiles. Rocketsondes can be used regardless of sea state or wind conditions onboard ship and require no specific ship maneuvering to safely launch. It is found that the rocketsonde can obtain the requisite environmental parameters for refractive assessment on demand in less than half the time required to prepare and launch a balloon guided radiosonde.

REMOTE MEASUREMENT OF AEROSOL OPTICAL PROPERTIES USING THE NOAA POES AVHRR AND GOES IMAGER DURING TARFOX

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A radiative transfer algorithm in the solar wavelengths for the NOAA POES AVHRR and GOES Imager is proposed for the cloud-free, marine atmosphere. The algorithm combines linear single-scattering theory with an estimate of bi-directional surface reflectance. Phase functions are parameterized using an aerosol distribution model and the ratio of radiance values measured in channels 1 and 2 of the AVHRR. Retrieved satellite aerosol optical depth is compared to airborne sunphotometer data and values derived from aerosol particle size distributions collected during the Tropospheric Aerosol Radiative Forcing Observational Experiment (TARFOX) in July 1996. Error in the satellite derived values from the AVHRR originates in error in modeling aerosol size distributions, corresponding phase function parameterization, and treatment of specular surface reflectance. Extension of the algorithm to the GOES Imager provided results consistent with the AVHRR.

A CASE STUDY OF HIGH WINDS INDUCED BY UPPER-LEVEL ERONTOGENESIS AND TROPOPAUSE FOLDING

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High surface winds over California and the bordering Pacific Ocean resulted in the death of one man and the loss of power to approximately 50,000 residences across the state. These damaging winds are hypothesized to result from an upper-level

front and associated tropopause folding that rapidly intensify as they move south across the region, causing high-momentum air to be transported to the lower troposphere. Once the high-momentum air reaches the top of the planetary boundary layer, the combined effects of destabilization of the planetary boundary layer by cold air advection aloft and shear-induced turbulence at the top of the layer provide the initial mechanism by which the high-momentum air is entrained into the layer and mixed to the surface. After sunrise, convectively-driven turbulence provides an additional source of mixing in the planetary boundary layer.

The winds have a strong cross-isobaric component in the direction of the upper-level winds, and the upper-level frontal movement to the south over central California is synchronous with the increase of surface winds over the same region. The winds decrease as the upper-level front moves into the base of the upper-level trough and the high-momentum source in the lower-troposphere disappears.

NAVAL INFRARED IMAGERY EXPLOITATION (U)
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Infrared Remote sensors often detect thermal excess energy emanating from naval ships through the discharge of seawater used to cool the equipment in the engineering spaces. Once the thermal energy has been detected, the properties associated with the production of that thermal energy could be simulated using a three-dimensional hydrodynamic model. The parameters of the engineering plant are estimated when the simulated thermal plume provides a good representation to the observed energy discharged into the harbor. The synergy of data obtained remotely combined with hydrodynamic modeling can provide insight to the intentions of the vessels.

OBSERVATIONS OF MESOSCALE CONVECTIVE SYSTEMS DURING TROPICAL CYCONE GENESIS
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A better understanding of the role mesoscale convective systems (MCS) play in the formation stages of tropical cyclones will increase the ability to predict their occurrence and motion. This thesis employs high-resolution geostationary satellite imagery to observe the interaction between MCSs and their environment. Specifically, thirteen cases of tropical disturbances that eventually developed into tropical cyclones are analyzed to determine the role of MCSs in increasing the system organization. Following two conceptual models developed during the Tropical Cyclone Motion (TCM-93) mini-field experiment, each tropical cyclone is classified according to the relative importance of MCS activity to its development. Both conceptual models are verified through analysis and a third model is created to account for tropical cyclone developments that share features of the previous two models. An alternate approach is proposed for determining tropical system organization through severe tropical cyclone strength using only visible and infrared satellite imagery.

AN EXAMINATION OF TWO SYNTHETIC APERTURE RADAR WIND RETRIEVAL MODELS DURING NORCSEX '95

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Synthetic Aperture Radar wind retrieval models have great potential to accurately depict the mesoscale wind field on the order of hundreds of meters. However, there are still significant hurdles to overcome in applying the theory in a fully automated algorithm. This thesis is a result of collaboration between the Nansen Environmental and Remote Sensing Center, Bergen, Norway and the Naval Postgraduate School. It examines two wind retrieval models on basis of in-situ and remote data from NORCSEX '95 in the interest of improving our understanding and application of these models. The individual models are based on Bragg backscatter from the ocean surface however, the CMOD4 model is directly related to the backscatter while the SWA model is related to the spectral resolution of the backscatter field. Each model has specific advantages and disadvantages related to processing and automation. For this data set they show very good agreement with each other and with in-situ measurements. Plots of optimum wind vectors derived from a combination of CMOD4 and SWA wind vectors are shown to illustrate the high resolution wind fields available with this technology.

DIURNAL VARIATION OVER THE TROPICAL MONSOON REGIONS DURING NORTHERN SUMMER 1991

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This study examines diurnal variation of convection over western India, the Bay of Bengal, Indochina and the northern South China Sea during the 1991 northern summer monsoon using combined Japanese (GMS) and Indian (INSAT) geostationary satellite data, ECMWF 850 hPa wind data, and NCEP sea surface temperature analyses.

The diurnal cycle is examined in terms of spatial and temporal structure prior to onset and during the monsoon. The northern South China Sea is examined to determine how different periods of synoptic influences resulted in an anomalously strong diurnal signal during June. The wind and Sea Surface Temperature (SST) data are used to examine the relationship between the diurnal variation of convection and both low-level convergence and vertical latent heat fluxes.

Convection over west India is most common during May and June and starts as a diurnal system over land that becomes organized and propagates westward over the east Arabian Sea. The Bay of Bengal follows the classic land-sea breeze model and convection is modulated by convergence between the land breeze and large-scale monsoon flow. The diurnal cycle is generally enhanced over the ocean during active phases of convective activity. The maximum latent heat fluxes generally occurs prior to maximum convection due to strong monsoon flow enhancing evaporation.

THE GENERATION AND CHARACTERIZATION OF SURF ZONE AEROSOLS AND THEIR IMPACT ON NAVAL ELECTRO-OPTICAL SYSTEMS

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Aerosols are generated within the surf zone by the breaking of waves along the beachfront. The concentration of aerosols, size, and structure of these plumes are impacted by the air/sea temperature differences, breaker type, and local winds. During the EOPACE I surf experiment at LaJolla, CA, it was observed that under light wind conditions, standing aerosol plumes would develop to heights of 31 meters. Concurrently, transmittance at FLIR wavelengths would be degraded up to 35%. Similar aerosol plume structures were observed during EOPACE II at Moss Landing, CA. These results are used to characterize and forecast standing plume conditions that may impact electro-optical transmission.

EXTRATROPICAL TRANSITION OF WESTERN NORTH PACIFIC TROPICAL CYCLONES

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Extratropical transition (ET) of a tropical cyclone (TC) often results in a mid-latitude storm that threatens maritime and coastal interests. Cases of ET between 1 July through 31 October during 1994-1996 are reviewed using Navy Operational Global Atmospheric Prediction System (NOGAPS) analyses and hourly geostationary satellite imagery. Current conceptual models are found to be inadequate to explain the physical processes in ET. ET is redefined to have two stages: transformation, where the TC is transformed from a warm-core vortex into a baroclinic, cold-core extratropical cyclone, and re-intensification, where the transformed TC either deepens or dissipates, depending on the existance of upper-tropospheric support for extratropical cyclogenesis. ET is further defined in terms of two chaacteristic mid-latitude synoptic patterns: meridional, in which the cyclones have meridional tracks and tend to re-intensify less vigorously than zonel, which have zonal tracks and may deepen explosively. Review of NOGAPS 500-mb anomaly correlation scores in 1996 demonstrated that ET may be associated with significant NOGAPS errors. Sea-level pressure forecasts during ET events involving a merger tend to be too deep. In ET cases of rapidly deepening storms. NOGAPS tends to overforecast their intensity during transformation, and then underforecast during reintensification. Rules of thumb are provided to assist forcasters in improving predictions of the track and intensity of storms undergoing ET.

OPERATIONAL EVALUATION OF THE ELECTRO-OPTIC TACTICAL DECISION AID, VERSION 3.1

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The Electro-Optical Tactical Decision Aid (EOTDA) is a tool weather forecasters use to predict target detection ranges and the performance of various electro-optic precision-guided weapon systems. The user inputs environmental and tactical information, such as the expected atmospheric conditions and target and background descriptions. The primary EOTDA

output are target detection ranges and thermal contrast information. The EOTDA supports three types of weapon systems: infrared (8-12 μm), visible (0.4-0.9 μm), and laser (1.06 μm). This study is an evaluation of the EOTDA performance of an infrared (Ho weapons system used during a training exercise at Naval Air Station (NAS) Fallon, Nevada in January 1996. In addition, a sensitivity study of the EOTDA parameters was completed. The results showed that the EOTDA predicted ranges within 20% of the observed detection ranges when correct environmental information was available. The most critical parameters required for the EOTDA were moisture, aerosol selection, the target area forecast, and composition of the target and background. Recognizing the strengths and weakness of the EOTDA will help operational users improve electro-optic forecasts and help guide future research and development efforts.

UNBALANCED FRONTOGENESIS WITH CONSTANT POTENTIAL VORTICITY
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The numerical model of Williams et al. (1992) is used to study frontogenesis from unbalanced initial conditions. The dependent variables are assumed to be independent of y. The hydrostatic Boussinesq primitive equations are used with no diffusion of heat or momentum. The model is bounded at the top and bottom by rigid planes. Periodic boundary conditions are used in the horizontal. The lateral boundaries are placed far enough from the imbalance region to avoid wave reflection. The atmosphere is assumed to have constant vertical temperature stratification.

The initial imbalance is obtained by allowing a horizontal temperature gradient to exist while the initial wind is zero. In a stably stratified atmosphere, gravity waves are excited and propagate away from the imbalance region, provided no reflection occurs in the lateral boundaries. Therefore, the atmosphere tends toward a geostrophic balance away from vertical boundaries. Near these boundaries, the temperature gradient oscillates or it collapses into a front, depending on the initial Rossby (Ro) and Froude (F) numbers. A relationship between Ro and F is established which separates situations where a front may or may not form. Numerical solutions show the formation of a front within a finite period of time that tilts toward the cold air.

A STUDY OF SOUTH ASIAN MONSOON CONVECTION AND TROPICAL UPPER EASTERLY JET DURING NORTHERN SUMMER 1991
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This work studies the 1991 northern summer monsoon over India and surrounding areas using Japanese (GMS) and Indian (INSAT) geostationary satellite data, the ECMWF objective re-analysis, and the NMC sea surface temperature analysis. Monthly and weekly mean fields are first used to examine the development of the monsoon over the entire domain and to identify the timing of the onset over India. Latent heat fluxes are shown to be important in the monsoon development process. The relationship between the synoptic variations of a convective index derived from satellite data and the upper tropospheric easterly jet show two possible effects of cumulus convection on the easterly jet. The first is a forcing of the jet maximum near southern India when convection flares up to the north in the monsoon trough. This is believed to be the result of the Coriolis acceleration of the southward outflow of the local Hadley cell. The second is a damping of the upper jet by cumulus momentum transport that occurs at the same location as the jet maximum. This second effect is most clearly shown in regions of strong vertical shear.

VIDEO CONFERENCING USING PACKET RADIO TECHNOLOGY

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Information and its effective delivering means are becoming more and more important in today's world. Video-conferencing is a highly effective means to deliver information since it is interactive. This thesis studies the packet-radio-networking technology that can be used to support video-conferencing applications. The popular networking protocols, i.e., the Amateur X.25 (AX.25), the Transport Control Protocol/Internet Protocol (TCP/IP), and other protocols, widely used in packet radio technology are described. By using the File Transfer Protocol (FTP) of the TCP/IP standard, the average speed and time of various file sizes across a half-duplex radio channel, a full-duplex emulated-radio channel, and a RS-232 link were collected and analyzed. Finally, comparisons were made among channels, including the effects of an additional routing node.

INVESTIGATION OF STRONG SURFACE WINDS ASSOCIATED WITH AN UPPER FRONT USING COAMPS

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On 2 April 1997, strong winds blew through the central coast of California that were accompanied by an intense jet streak and upper front. The event was analyzed with standard synoptic-scale DIFAX charts and mesoscale charts for comparison. The mesoscale model used was the Coupled Ocean/Atmosphere Mesoscale Prediction System (COAMPS) developed by Naval Research Laboratory (NRL), Monterey, California.

COAMPS captured features that were not diagnosed on the synoptic charts. Height, isotach and temperature fields showed more detail, although observations were not sufficient to completely verify the model's level of detail. COAMPS was heavily influenced by the topographic field modeling lee troughs and mountain waves along the Sierra Nevada mountains. A strong mountain wave, initiated by the upper front, occurred in central California during this time period. The wave troughs correlated to wind maxima at the surface, including one near San Francisco Bay where winds as high as 66 mph were reported.

A COMPARISON OF UPPER FRONT STRENGTH AS ANALYZED BY NORAPS AND AS OBSERVED BY ACARS-EQUIPPED AIRCRAFT

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Upper fronts are associated with strong horizontal gradients of both temperature and wind speed on a scale that is not well resolved by rawinsonde observations. Even so, mesoscale data assimilation systems are capable of ingesting observations from a variety of sources and depicting such features. This study examines upper fronts that occurred over the continental U.S. during March-April 1996 with the objective of verifying the performance of the NORAPS (Navy Operational Regional Atmospheric Prediction System) data assimilation system using ACARS (ARTNC Communications, Addressing, And Reporting System) aircraft observations. ACARS observations are taken every 5-8 minutes during level flight, which yields a horizontal resolution along the flight track of less than 100 km and so can resolve the approximately 200 km width scale for upper fronts. The ACARS temperature observations are not currently used in the data assimilation system and so present an independent set of observations.

Thirty distinct upper fronts (duration greater than 12 h and temperature gradient greater than 2°C/l00km) were identified and tracked from the NORAPS analyses during the period of the study. In general, the analyzed temperature gradient was weaker than that observed in the ACARS data. The latter depicted a temperature gradient of 8°C/ 100 km for two cases, whereas the analyzed gradient did not exceed 6°C/100 km. Most upper fronts (47%) attained maximum intensity when located in the base of the upper-level trough, although 33% (13%) did so just downstream (upstream) of the trough line. Most of the useable aircraft tracks were near 200-300 mb, therefore the portion of the upper front above the tropopause was examined in greater detail than the portion below the tropopause, although the latter would be expected to contain stronger temperature gradients

SENSITIVITY OF THE CALIFORNIA COASTAL JET TO SYNOPTIC SCALE FLOW

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The California Coastal Jet can have a significant impact on many operations. This study examines the sensitivity of the California Coastal Jet to the synoptic-scale flow by examining the surface reflection of the jet at a particular buoy (buoy 46028) off the Central California coast. Statistical analysis and subjective examination of surface charts were performed to help determine the relationship between the synoptic flow regime and the observed surface winds. The main results of the study are: (1) The magnitude of the California Coastal Jet is sensitive to the geostrophic wind direction, (2) The surface reflection of the California Coastal Jet at buoy 46028 does not exhibit diurnal variation. The day to day variability in the observed winds is much larger than the diurnal variation at buoy 46028, and (3) Higher wind speed events at buoy 46028 correspond to periods when meso-scale effects such as flow blocking and supercritical flow are important and are missed in the analysis. Lower wind speed events correspond to periods when the synoptic-scale analyses successfully describe the coastal flow.

DEEP MIXED LAYER ENTRAINMENT

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A bulk turbulence-closure mixed layer model is generalized to allow prediction of very deep polar sea mixing. The model includes unsteady three-component turbulent kinetic energy budgets. In addition to terms for shear production, pressure redistribution, and dissipation, special attention is devoted to realistic treatment of thermobaric enhancement of buoyancy flux and to Coriolis effects on turbulence. The model is initialized and verified with CTD data taken by R/V *Valdivia* in the Greenland Sea during winter 1993-1994. Model simulations show: (i) mixed layer deepening is significantly enhanced when the thermal expansion coefficient's increase with pressure is included; (ii) entrainment rate is sensitive to the direction of wind stress because of Coriolis; and (iii) the predicted mixed layer depth evolution agrees qualitatively with the observations. Results demonstrate the importance of water column initial conditions, accurate representation of strong surface cooling events, and inclusion of the thermobaric effect on buoyancy, to determine the depth of mixing and ultimately the heat and salt flux into the deep ocean. Since coupling of the ocean to the atmosphere through deep mixed layers in polar regions is fundamental to our climate system, it is important that regional and global models be developed that incorporate realistic representation of this coupling.

THE ASSIMILATION OF SATELLITE ALTIMETER DATA INTO A GLOBAL EDDY RESOLVING OCEAN MODEL

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Two assimilation experiments have been conducted using the Semtner/Chervin Parallel Ocean Climate Model at 1/4˚ resolution to investigate the dynamical changes which occur with the application of the nudging method to incorporate sea surface height observations (with associated vertical corrections to temperature and salinity) into a global eddy resolving ocean model. The first experiment used a previous model run as the observational field to determine if the assimilation technique, nudging, produced significant changes in the simulated fields to adjust the model to the observed fields when starting at a statistically different initial condition. The twin experiment has shown that the model does respond to the inclusion of the observed fields. Both the surface fields and subsurface fields have been adjusted towards these synthetic observations. The second experiment involved the use of a combined altimetric sea surface height anomaly field from the ERS-1 and the T/P satellites. The surface height fields are extended vertically by using the Levitus 94 monthly climatological fields. This dissertation has shown that assimilation of surface height data and an associated vertical adjustment to temperature and salinity, modifies both the surface and subsurface fields. Changes can be seen in both prognostic and diagnostic quantities (such as heat content and meridional overturning) while remaining dynamically consistent with the numerics of the model itself. Comparison of the simulated fields with in situ observations of temperature and salinity show that the model has adjusted towards observation not included in the assimilation process.

A STUDY OF THE SURFACE HEAT BUDGET OF THE WEDDELL SEA USING A RADIATIVE TRANSFER MODEL DURING THE AUSTRAL WINTER 1994

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This study uses rawinsonde soundings and irradiance measurements taken in the Weddell Sea during the 1994 ANZFLUX experiment. A radiative transfer model was used to determine the influence of aerosols, cloud droplet size, and water content on the radiative heat budget of the Weddell Sea. The modeled irradiances were compared with observations, and the model calculated the upward longwave irradiance from the Weddell Sea ice pack. Turbulent heat fluxes were calculated and combined with radiative terms to provide a net heat flux at the ice surface. While turbulent heat flux is the major factor affecting the Weddell Sea's heat budget in windy conditions, during calm conditions longwave radiative transfer becomes important. The modeled downward irradiances were compared to results obtained from empirical equations developed for the Weddell Sea during the winter. The atmosphere above the Weddell Sea appears to have an aerosol structure similar to marine environments. Stratus clouds over the Weddell Sea appear to be made up of cloud droplets with an effective radius of 2.5 microns and a water concentration close to 0.05 grams per cubic meter. The dominant terms in the surface heat budget are the longwave irradiances with the upward longwave term being the largest.